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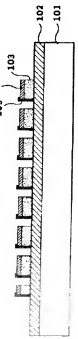
(54)【発明の名称】　イメージセンサ

(57)【要約】

【課題】　１０００ｎｍ以上の近赤外波長で動作可能なイメージセンサおよび高感度なイメージセンサを提供すること。

【解決手段】　Ｓｉ基板１０１上に集積回路として電子回路１０２を設けた基板の電子回路上に絶縁層としてのポリイミド絶縁層１０３を介して光検出部として光検出器１０４がアレイ状に集積して光検出器アレイを有するイメージセンサを構成する。



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【特許請求の範囲】

【請求項1】　光検出器アレイを有するイメージセンサであって、
光検出部と、
集積回路部とから構成され、
集積回路部上に絶縁層を介して光検出部がアレイ状に集積されていることを特徴とするイメージセンサ。

【請求項2】　前記集積回路部が電荷結合素子（ＣＣＤ）を具備し、
前記光検出部の各光検出器の出力を読み出す構成を有することを特徴とする請求項１記載のイメージセンサ。

【請求項3】　前記集積回路部がＣＭＯＳ(Complementary Metal-Oxide-Semiconductor) 回路により構成されていることを特徴とする請求項１または２記載のイメージセンサ。

【請求項4】　前記絶縁層がポリイミド材料からなることを特徴とする請求項１〜３のいずれかに記載のイメージセンサ。

【請求項5】　前記光検出部が波長１０００ｎｍ以上で感度を有する材料からなる受光層を備えることを特徴とする請求項１〜４のいずれかに記載のイメージセンサ。

【請求項6】　前記光検出部がＳｉ以外の半導体材料からなる受光層を有することを特徴とする請求項１〜５のいずれかに記載のイメージセンサ。

【請求項7】　前記光検出部がＩｎＧａＡｓからなる受光層と、ｎ−ＩｎＰ層と、ｐ−ＩｎＰ層とを含むことを特徴とする請求項６記載のイメージセンサ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、イメージセンサに関し、特に二次元光情報を電子情報に変換するイメージセンサに関する。

【０００２】

【従来の技術】二次元光情報を電子情報に変換するイメージセンサには、従来、ＣＣＤイメージセンサとＣＭＯＳイメージセンサが知られている。どちらもＳｉ基板上のプロセス技術であり、光検出部にはＳｉの光検出器が用いられている。すなわち、Ｓｉの材料特性で決まる波長、２００ｎｍ〜１０００ｎｍの範囲の画像のみを検出できる。第１の従来の技術の問題点は、１０００ｎｍ以上の近赤外領域の画像検出が不可能なことである。

【０００３】また、従来のイメージセンサでは、各画素の寸法は１０μｍ角程度であるが、光検出器以外の電子回路がその一部を占めるので、光検出器の面積占有率が小さい。これは特にＣＭＯイメージセンサで著しく占有率は高々２０％である。このため、マイクロレンズ等で集光しないと受光時に大きな損失が生じ、画質とＳ／Ｎ[illegible]くなる。また、光検出器の面積占有率を高めるとＣ[illegible]部およびＣＭＯＳ部の占める領域に[illegible]必要があり、画素の集積度を高めることが困難になる。

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第２の従来の技術の問題点は、光検出器の面積占有率が低いことである。

【０００４】

【発明が解決しようとする課題】本発明は、このような背景の下になされたもので、１０００ｎｍ以上の近赤外波長で動作可能なイメージセンサおよび高感度なイメージセンサを提供することにある。

【０００５】

【課題を解決するための手段】請求項１記載のイメージセンサは、光検出器アレイを有するイメージセンサであって、光検出部と、集積回路部とから構成され、集積回路部上に絶縁層を介して光検出部がアレイ状に集積されていることを特徴とする。

【０００６】請求項２記載のイメージセンサは、請求項１記載のイメージセンサにおいて、前記集積回路部が電荷結合素子（ＣＣＤ）を具備し、前記光検出部の各光検出器の出力を読み出す構成を有することを特徴とする。

【０００７】請求項３記載のイメージセンサは、請求項１または２記載のイメージセンサにおいて、前記集積回路部がＣＭＯＳ(Complementary Metal-Oxide-Semiconductor) 回路により構成されていることを特徴とする。

【０００８】請求項４記載のイメージセンサは、請求項１〜３のいずれかに記載のイメージセンサにおいて、前記絶縁層がポリイミド材料からなることを特徴とする。

【０００９】請求項５記載のイメージセンサは、請求項１〜４のいずれかに記載のイメージセンサにおいて、前記光検出部が波長１０００ｎｍ以上で感度を有する材料からなる受光層を備えることを特徴とする。

【００１０】請求項６記載のイメージセンサは、請求項１〜５のいずれかに記載のイメージセンサにおいて、前記光検出部がＳｉ以外の半導体材料からなる受光層を有することを特徴とする。

【００１１】請求項７記載のイメージセンサは、請求項６記載のイメージセンサにおいて、前記光検出部がＩｎＧａＡｓからなる受光層と、ｎ−ＩｎＰ層と、ｐ−ＩｎＰ層とを含むことを特徴とする。

【００１２】

【発明の実施の形態】以下、図面を参照して、本発明の実施例を説明するが、本発明はこれらの実施例に限定されないことはもちろんである。

【００１３】（実施例１）図１に本発明の第１の実施例を示す。ここで、１０１はＳｉ基板、１０２はＣＣＤを具備する電子回路、１０３はポリイミド絶縁層、１０４は光検出器、１０５は電子回路と光検出器を接続する配線である。図２に本実施例の一つの画素の断面図を示す。ここで、１０６はＣＣＤ回路、１０７はＬＳＩ層間絶縁膜、１０８は層間を接続するコンタクトホールを[illegible]Ａｌ電極、１０９はＡｌ配線、[illegible]Ｐ層、１１１は[illegible]ＧａＡｓ層、１１２は[illegible]Ｐ層、[illegible]絶縁膜である。[illegible]

低減するために、配線１０とｎ－ＩｎＰ層１１２との間に高ドープｎ－ＩｎＧａＡｓＰ層、配線１０５とｐ－ＩｎＰ層１１０との間に高ドープｐ－ＩｎＧａＡｓＰ層が設けられることもある。この構成では、光検出部としての光検出器１０４と隣接する光検出器１０４との間の分離部分と電極により光が遮られる部分を除いて受光することが可能であり、光検出器の面積占有率を９０％程度にすることが可能である。勿論、適当なマイクロレンズアレイを素子上面に配置すればほぼ１００％の光を受光面で受けることができることはいうまでもない。

【００１４】図３に本実施例のブロック配線図を示す。ここで、１１４は行方向ＣＣＤアレイ、１１５は光検出部、１１６は列方向ＣＣＤアレイ、１１７は増幅回路である。電気的および論理的な接続は従来のＣＣＤイメージセンサと同様である。光検出部１１５で検出された光は電子に変換され、一定の時間蓄積された後、隣接する行方向ＣＣＤアレイ１１４のＣＣＤに出力され、クロックで順にＣＣＤ間を伝送され、列方向ＣＣＤアレイ１１６を経て増幅回路１１７に至り、各画素の光量に応じた電荷が順に増幅回路１１７から出力される。この構成では、光検出部１１５で、ＩｎＧａＡｓを受光層に、ＩｎＰをｐ／ｎ層に用いている（図２において、ｐ－ＩｎＰ層１１０，ｉ－ＩｎＧａＡｓ層１１１およびｎ－ＩｎＰ層１１２）ので、波長９００ｎｍから１６００ｎｍの程度の範囲で感度がある。他の半導体材料でも、本発明に用いることができることはいうまでもない。例えば、波長１５００ｎｍ以上の中赤外領域では、ＧａＩｎＡｓＳｂ系材料、ＩｎＡｓＳｂＰ系材料を用いることが可能であるし、さらに遠赤外領域ではＰｂＳＳｅ系、ＰｂＳｎＳｅ系、ＰｂＳｎＳｅＴｅ系、ＰｂＳｅＴｅ系の材料を用いることが可能である。ただし、遠赤外の光検出の場合は素子を冷却する必要がある。また、光検出器にＳｉを用いることも当然可能である。この場合は受光波長は従来のイメージセンサと同様であるが、面積占有率を高めることが可能である。また、光検出器の容量がＣＭＯＳプロセスによる光検出器に比較して低減されるので次に述べる第２の実施例に対して有効である。その他にも、ＧａＡｓ，Ｇｅ，ＡｌＧａＡｓ系、ＩｎＧａＡｓＰ系、ＧａＮＡｓ系、ＧａＳｂ，ＧａＰ，ＧａＡｓＰ系、ＩｎＳｂ，ＩｎＡｓ，ＩｎＧａＳｂ系等の半導体材料を光検出器に用いることができる。

【００１５】図４（ａ）～（ｇ）を参照して製作方法について説明する。図４（ａ）に示すのはＳｉ基板１０１上に既に集積回路としてＣＣＤを含む電子回路１０２が形成された基板であり、表面に光検出器１０４（図１）と接続するためのＡｌ配線１０９が露出している。Ａｌ配線１０９はコンタクトホールの底に露出している場合もある。この状態では基板表面に凹凸があるので [illegible] が必要である。図４（ｂ）に示すのは [illegible] を基板表面に塗布した状態である。この状態で、温度を上げるとポリイミド１１８が固化する。固化した後に研磨機によって電極面が露出するまでポリイミド１１８を研磨する。あるいは、数千オングストローム程度ポリイミド１１８を残し、ドライエッチング装置でエッチングして電極面を露出させてもよい。これにより、Ｓｉ基板上にＣＣＤを含む電子回路１０２が形成される。研磨して平坦化された状態を図４（ｃ）に示す。再び別のポリイミド絶縁層１０３を設け、これを介して、光検出器の層構造１１９が成長されたＩｎＰ基板１２０を、光検出器の層構造１１９がポリイミド絶縁層１０３に接するように張り付ける。ここで、仮固定のため低温でポリイミド絶縁層１０３を僅かに固化させる（図４（ｄ））。この状態で余分なＩｎＰ基板１２０を臭素／メタノール系の高速エッチングおよび塩酸系選択エッチングを用いて剥離する。この場合、高速エッチングで１００ミクロン弱にした後に選択エッチングを行う。このため、光検出器の層構造１１９とＩｎＰ基板１２０の間にＩｎＧａＡｓあるいはＩｎＧａＡｓＰの選択エッチング層（図示しない）を設けてある。この選択エッチング層は硫酸／過酸化水素系エッチャントを用いてエッチングする。この状態を図４（ｅ）に示す。次に各画素に分割する。これは、Ｓｉ基板１０１上のマーカー（図示しない）を用いて裏面から近赤外光の照明を用いてマスク（図示しない）と位置合わせをすれば、通常のフォトリソグラフィ技術で可能である。あるいは、部分的に光検出器の層構造１１９およびポリイミド絶縁層１０３をエッチングし、ＣＣＤを含む電子回路１０２を露出させ、このＣＣＤを含む電子回路１０２上に設けられたマーカーを用いて位置合わせを行ってもよい。画素への分割には塩素／アルゴン系ないし、臭素／アルゴン系のリアクティブイオンビームエッチング（ＲＩＥ）装置を用いるのがよい。この分割により、光検出器の層構造１１９は個々の光検出器１０４（図１）に分離される。この状態を図４（ｆ）に示す。必要に応じてポリイミド絶縁層１０３の部分も分割される。また、Ａｌ配線１０９との配線のため、ポリイミド絶縁層１０３の一部が酸素系リアクティブイオンビームエッチング（ＲＩＥ）装置等でエッチングされる。次に、ポリイミドが完全に固化する温度まで温度を上げる処理を行う。この後、配線１０５によって電極間の配線が行われる。配線後、抵抗を低減するために４００℃程度のシンタリングが行われる。必要に応じて、配線１０９と配線１０５との間にＴｉ／Ｐｔ／Ａｕ、Ｔｉ／Ｎｉ／Ａｕ等のバリア金属多層膜が設けられる。この状態を（ｇ）に示す。

【００１６】（実施例２）図５は、集積回路がＣＭＯＳ回路により構成される本発明の第２の実施例によるイメージセンサを [illegible] 配線図である。ここで、１２ [illegible] 、１２２は増幅回路、１２ [illegible] 回路、１２４は画素内増幅回路である。また、図 [illegible] に画素の [illegible] を示す。本実施例によるイメージセンサ

サの動作は、通常のＣＣＤイメージセンサと同様であり、リセットクロックの周期内で受光して光電変換した電荷を蓄積し、行指定がイネーブルになると読み出され、増幅回路１２２で増幅されて列デコーダ回路１２３内のレジスタに記憶される。これを順次行うことでイメージ情報がパラレルシリアル変換されて出力される。本実施例によるイメージセンサは第１の実施例によるイメージセンサと同様の製造方法に従って製造できる。

【００１７】第１および第２の実施例によるイメージセンサは２次元イメージセンサとして説明したが、本発明は１次元のリニアイメージセンサに適用できることはいうまでもない。

【００１８】

【発明の効果】以上に説明したように、本発明では、光検出部をアレイ上に集積されていることにより、光検出部の面積占有率が高い高感度のイメージセンサを実現することができる。また、赤外光に対して感度があり、光検出部の面積占有率が高い高感度のイメージセンサを実現することができる。

【図面の簡単な説明】

【図１】本発明の第１の実施例によるイメージセンサの構成図である。

【図２】本発明の第１の実施例によるイメージセンサの断面図である。

【図３】本発明の第１の実施例によるイメージセンサのブロック配線図である。

【図４】本発明の第１の実施例によるイメージセンサの製造方法を説明する断面図であり、（ａ）はＣＣＤを含む電子回路が形成された基板、（ｂ）はポリイミドを塗布した基板、（ｃ）は研磨して平坦化した基板、（ｄ）はポリイミドに光検出器の層構造が成長されたｐ－ＩｎＰ基板を張り付けられた状態の基板、（ｅ）は選択エッチングを行った基板、（ｆ）は各画素に分割した基板、（ｇ）は電極間の配線を行った基板、をそれぞれ示す。

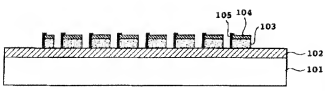
【図５】本発明の第２の実施例によるイメージセンサのブロック配線図である。

【図６】本発明の第２の実施例によるイメージセンサの画素の回路図である。

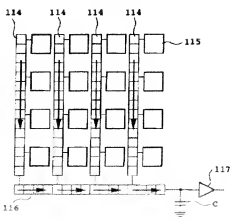
【符号の説明】

１０１　Ｓｉ基板
１０２　ＣＣＤを含む電子回路
１０３　ポリイミド絶縁層
１０４　光検出器
１０５　配線
１０６　ＣＣＤ回路
１０７　ＬＳＩの層間絶縁膜
１０８　Ａｌ配線
１０９　Ａｌ配線
１１０　ｐ－ＩｎＰ層
１１１　ｉ－ＩｎＧａＡｓ層
１１２　ｎ－ＩｎＰ層
１１３　ＳｉＮ絶縁膜
１１４　行方向ＣＣＤアレイ
１１５　光検出部
１１６　列方向ＣＣＤアレイ
１１７　増幅回路
１１８　ポリイミド
１１９　光検出器の層構造
１２０　ＩｎＰ基板
１２１　行デコーダ回路
１２２　増幅回路
１２３　列デコーダ回路
１２４　画素内増幅回路

【図１】



【図３】



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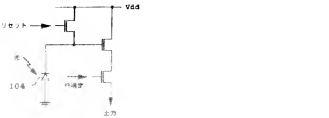

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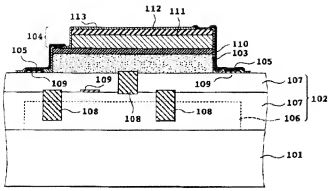

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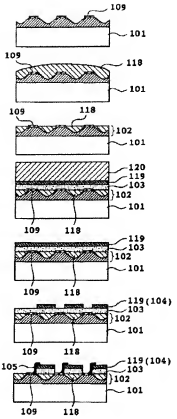

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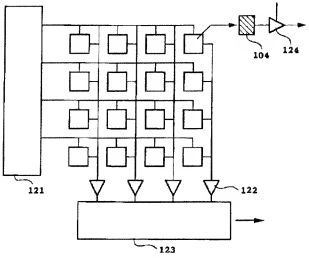

フロントページの続き

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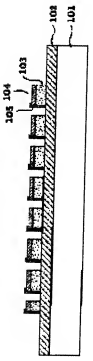
(54) IMAGE SENSOR

(57)Abstract:
PROBLEM TO BE SOLVED: To increase the area occupation of a photo-detecting part for high sensitivity, by providing the photo-detecting part and an integrated circuit part, and integrating the photo-detecting part in array on an integrated circuit through an insulating layer.
SOLUTION: An electronic circuit 102 comprising a CCD as an integrated circuit is provided on an Si substrate 101, and a photo-detector 104 is provided in array on the electronic circuit 102 through a polyimide insulating layer 103. The electronic circuit 102 and the photo-detector 104 are connected together with a wiring 105. With this configuration, light is received except the separation part between the photo-detector 104 which is a photo-detection part and an adjoining photo-detector 104 and a part where light is shielded by an electrode. Thus, the area occupancy by photo-detectors is about 90%. For example, by providing an appropriate micro lens array on an element, almost 100% of light is received on a light-reception surface. So, an image sensor of high sensitivity which is sensitive to infrared light with high area-occupancy of a photo-detection part is provided.



CLAIMS

[Claim(s)]
[Claim 1]An image sensor, wherein it is an image sensor which has a photodetector array, it comprises a photodetection part and an integrated circuit unit and a photodetection part is accumulated by array form via an insulating layer on the integrated circuit unit.
[Claim 2]The image sensor according to claim 1 having the composition which said integrated circuit unit possesses a charge coupled device (CCD), and reads an output of each photodetector of said photodetection part.
[Claim 3]Said integrated circuit unit is CMOS (Complementary Metal-Oxide-Semiconductor). The image sensor according to claim 1 or 2 being constituted by circuit.
[Claim 4]The image sensor according to any one of claims 1 to 3, wherein said insulating layer consists of polyimide material.
[Claim 5]The image sensor according to any one of claims 1 to 4, wherein said photodetection part is provided with a euphotic zone which consists of material which has sensitivity on wavelength of not less than 1000 nm.
[Claim 6]The image sensor according to any one of claims 1 to 5, wherein said photodetection part has a euphotic zone which consists of semiconductor materials other than Si.
[Claim 7]The image sensor comprising according to claim 6:
A euphotic zone which said photodetection part becomes from InGaAs.
n-InP layer.
p-InP layer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially this invention relates to the image sensor which changes two-dimensional light information into electronic intelligence about an image sensor.
[0002]
[Description of the Prior Art]CCD series and a CMOS image sensor are conventionally known by the image sensor which changes two-dimensional light information into electronic intelligence. Both are the process technology on a Si substrate, and the photodetector of Si is used for the photodetection part. That is, only the picture of the wavelength decided by the material property of Si and the range of 200 nm - 1000 nm is detectable. The problem of the 1st Prior art is that picture detection of a not less than 1000-nm near infrared region is impossible.
[0003]Although the size of each pixel is a 10-micrometer angle grade in the conventional image sensor, since electronic circuits other than a photodetector occupy the part, the area share of a photodetector is small. This is at most 20% in share remarkably especially in a CMO image sensor. For this reason, if it does not condense with a micro lens etc., the big loss at the time of

light-receiving will arise, and degradation of image quality and S/N will become large. If the area share of a photodetector is raised, it is necessary to perform processing of a CCD part and a CMOS section minutely, and it will become difficult to raise the degree of location which is a pixel. The problem of the 2nd Prior art is that the area share of a photodetector is low.

[0004]

[Problem(s) to be Solved by the Invention]This invention was made under such a background and there is in providing the image sensor and the high sensitivity image sensor not less than 1000-nm which can operate on near-infrared wavelength.

[0005]

[Means for Solving the Problem]The image sensor according to claim 1 is an image sensor which has a photodetector array, it comprises a photodetection part and an integrated circuit unit, and a photodetection part is accumulated by array form via an insulating layer on the integrated circuit unit.

[0006]In the image sensor according to claim 1, said integrated circuit unit possesses a charge coupled device (CCD), and the image sensor according to claim 2 has the composition which reads an output of each photodetector of said photodetection part.

[0007]In the image sensor according to claim 1 or 2, as for the image sensor according to claim 3, said integrated circuit unit is CMOS (Complementary Metal-Oxide-Semiconductor). It is constituted by circuit.

[0008]As for the image sensor according to claim 4, said insulating layer consists of polyimide material in the image sensor according to any one of claims 1 to 3.

[0009]The image sensor according to claim 5 is provided with a euphotic zone which consists of material in which said photodetection part has sensitivity on wavelength of not less than 1000 nm in the image sensor according to any one of claims 1 to 4.

[0010]The image sensor according to claim 6 has a euphotic zone which said photodetection part becomes from semiconductor materials other than Si in the image sensor according to any one of claims 1 to 5.

[0011]The image sensor according to claim 7 is [this invention] characterized by that the image sensor according to claim 6 comprises the following.

A euphotic zone which said photodetection part becomes from InGaAs.

n-InP layer.

p-InP layer.

[0012]

[Embodiment of the Invention]As for this invention, although the example of this invention is hereafter described with reference to drawings, it is needless to say that it is not limited to these examples.

[0013](Example 1) The 1st example of this invention is shown in drawing 1. It is the wiring whose 105 the electronic circuit where, as for 101, a Si substrate and 102 possess CCD, and 103 connect a polyimide insulating layer here. 104 connects a photodetector, and connects an

electronic circuit and a photodetector. The sectional view of one pixel of this example is shown in drawing 2. As for p-InP layer and 111, the Al wiring for which the contact hole for which 106 connects a CCD circuit, 107 connects the interlayer insulation film of LSI, and 108 connects between layers was passed here, and 109 are [n-InP layer and 113] SiN insulator layers i-InGaAs layer and 112 Al wiring and 110. In order to reduce contact resistance, high dope p-InGaAsP layers may be provided between high dope n-InGaAsP layers, and the wiring 105 and p-InP layer 110 between the wiring 10 and n-InP layer 112. It is possible to receive light in this composition except for the leaver section between the photodetector 104 as a photodetection part and the adjoining photodetector 104 and the portion in which light is interrupted by the electrode, and it is possible to make the area share of a photodetector about 90%. Of course, if a suitable microlens array is arranged on the element upper surface, it cannot be overemphasized that about 100% of light can be received in an acceptance surface.

[0014]The block wiring diagram of this example is shown in drawing 3. Here, as for a line writing direction CCD array and 115, a column direction CCD array and 117 are amplifying circuits a photodetection part and 116 114. Electric and logical connection is the same as that of the conventional CCD series. The light detected in the photodetection part 115 is changed into an electron, and After [fixed] time accumulation was carried out, It is outputted to CCD of adjoining line writing direction CCD array 114, and between CCD is transmitted in order with a clock, the amplifying circuit 117 is reached through column direction CCD array 116, and the electric charge according to the light volume of each pixel is outputted from the amplifying circuit 117 in order. In this composition, there is sensitivity in the range of a grade with a wavelength of 900 to 1600 nm by that which uses InGaAs for a euphotic zone and uses InP for p/n layer in the photodetection part 115 (they are p-InP layer 110, i-InGaAs layer 111, and n-InP layer 112 in drawing 2). It cannot be overemphasized that other semiconductor materials can be used for this invention. For example, it is possible to use GaInAsSb system material and InAsSbP system material, and it is possible to use the material of a PbSSe system, a PbSnSe system, a PbSnSeTe system, and a PbSeTe system further in a far infrared region in a with a wavelength of not less than 1500 nm inside infrared region. However, in the case of far-infrared photodetection, it is necessary to cool an element. Naturally it is also possible to use Si for a photodetector. In this case, although light-receiving wavelength is the same as that of the conventional image sensor, it is possible to raise the area share. Since the capacity of a photodetector is reduced as compared with the photodetector by a CMOS process, it is effective to the 2nd example described below. In addition, semiconductor materials, such as a GaAs, germanium, and AlGaAs system, InGaAsP system, GaNAs system, GaSb, GaP, and GaAsP system, InSb, InAs, and InGaSb system, can be used for a photodetector.

[0015]Drawing 4 (a) A manufacturing method is explained with reference to - (g). What is shown in drawing 4 (a) is the substrate with which the electronic circuit 102 which already contains CCD as an integrated circuit was formed on Si substrate 101, and Al wiring 109 for connecting with the photodetector 104 (drawing 1) is exposed to the surface. Al wiring 109 may be exposed to the bottom of a contact hole. In this state, since unevenness is shown in a substrate

face, flattening of a substrate is required. What is shown in drawing 4 (b) is in the state which applied the polyimide solution to the substrate face. If temperature is raised in this state, the polyimide 118 will solidify. The polyimide 118 is ground until an electrode surface is exposed with a grinder after solidifying. Or it may leave the about thousands of A polyimide 118, it may etch with a dry etching system, and an electrode surface may be exposed. Thereby, the electronic circuit 102 containing CCD is formed on a Si substrate. The state where flattening was ground and carried out is shown in drawing 4 (c). Another polyimide insulating layer 103 is formed again, and via this, InP substrate 120 the layer system 119 of the photodetector grew up to be is stuck so that the layer system 119 of a photodetector may touch the polyimide insulating layer 103. Here, the polyimide insulating layer 103 is slightly solidified at low temperature for temporary fastening (drawing 4 (d)). Excessive InP substrate 120 is exfoliated using high-speed etching of bromine/methanol system, and chloride system selective etching in this state. In this case, selective etching is performed after using a little less than 100 microns by high-speed etching. For this reason, the selective etching layer (not shown) of InGaAs or InGaAsP is provided between the layer system 119 of a photodetector, and InP substrate 120. This selective etching layer is etched using sulfuric acid / hydrogen peroxide system etchant. This state is shown in drawing 4 (e). Next, it divides into each pixel. This is possible at the usual photolithography technique, if a mask (not shown) and alignment are carried out using the lighting of a near infrared using the marker (not shown) on Si substrate 101 from a rear face. Or the layer system 119 and the polyimide insulating layer 103 of a photodetector may be etched selectively, the electronic circuit 102 containing CCD may be exposed, and alignment may be performed using the marker established on the electronic circuit 102 containing this CCD. It is good for division into a pixel to use the reactive ion-beam-etching (RIE) device of chlorine / argon system thru/or bromine/argon system. The layer system 119 of a photodetector is separated into each photodetector 104 (drawing 1) by this division. This state is shown in drawing 4 (f). The portion of the polyimide insulating layer 103 is also divided if needed. A part of polyimide insulating layer 103 is etched with an oxygen system reactive ion-beam-etching (RIE) device etc. for wiring with Al wiring 109. Next, processing which raises temperature to the temperature which polyimide solidifies thoroughly is performed. Then, inter-electrode wiring is performed by the wiring 105. After wiring, in order to reduce resistance, about 400 ** sintering is performed. Metal barrier multilayer films, such as Ti/Pt/Au and Ti/nickel/Au, are provided between the wiring 109 and the wiring 105 if needed. This state is shown in (g).

[0016](Example 2) Drawing 5 is a block wiring diagram in which an integrated circuit shows the image sensor by the 2nd example of this invention constituted by the CMOS circuit. Here, as for a row decoder circuit and 122, a column-decoders circuit and 124 are the amplifying circuits in a pixel an amplifying circuit and 123 121. The example of a circuit of a pixel is shown in drawing 6. Operation of the image sensor by this example will be read, if it is the same as that of the usual CCD series, the electric charge which received and carried out photoelectric conversion within the cycle of a reset clock is accumulated and line specification is enabled, it is amplified in the amplifying circuit 122, and is memorized by the register in the column-decoders circuit 123. By

performing this one by one, parallel serial conversion of the image information is carried out, and it is outputted. The image sensor by this example can be manufactured in accordance with the same manufacturing method as the image sensor by the 1st example.

[0017]Although the image sensor by the 1st and 2nd examples was explained as a two-dimensional image sensor, it cannot be overemphasized that this invention is applicable to a one-dimensional linear image sensor.

[0018]

[Effect of the Invention]As explained above, in this invention, the image sensor of high sensitivity with the high area share of a photodetection part is realizable by accumulating the photodetection part on the array. There is sensitivity to infrared light and the image sensor of high sensitivity with the high area share of a photodetection part can be realized.

TECHNICAL FIELD

[Field of the Invention]Especially this invention relates to the image sensor which changes two-dimensional light information into electronic intelligence about an image sensor.

PRIOR ART

[Description of the Prior Art]CCD series and a CMOS image sensor are conventionally known by the image sensor which changes two-dimensional light information into electronic intelligence. Both are the process technology on a Si substrate, and the photodetector of Si is used for the photodetection part. That is, only the picture of the wavelength decided by the material property of Si and the range of 200 nm - 1000 nm is detectable. The problem of the 1st Prior art is that picture detection of a not less than 1000-nm near infrared region is impossible.

[0003]Although the size of each pixel is a 10-micrometer angle grade in the conventional image sensor, since electronic circuits other than a photodetector occupy the part, the area share of a photodetector is small. This is at most 20% in share remarkably especially in a CMO image sensor. For this reason, if it does not condense with a micro lens etc., the big loss at the time of light-receiving will arise, and degradation of image quality and S/N will become large. If the area share of a photodetector is raised, it is necessary to perform processing of a CCD part and a CMOS section minutely, and it will become difficult to raise the degree of location which is a pixel. The problem of the 2nd Prior art is that the area share of a photodetector is low.

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, in this invention, the image sensor of high sensitivity with the high area share of a photodetection part is realizable by accumulating the photodetection part on the array. There is sensitivity to infrared light and the image sensor of high sensitivity with the high area share of a photodetection part can be realized.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]This invention was made under such a background and there is in providing the image sensor and the high sensitivity image sensor not less than 1000-nm which can operate on near-infrared wavelength.

MEANS

[Means for Solving the Problem]The image sensor according to claim 1 is an image sensor which has a photodetector array, it comprises a photodetection part and an integrated circuit unit, and a photodetection part is accumulated by array form via an insulating layer on the integrated circuit unit.

[0006]In the image sensor according to claim 1, said integrated circuit unit possesses a charge coupled device (CCD), and the image sensor according to claim 2 has the composition which reads an output of each photodetector of said photodetection part.

[0007]In the image sensor according to claim 1 or 2, as for the image sensor according to claim 3, said integrated circuit unit is CMOS (Complementary Metal-Oxide-Semiconductor). It is constituted by circuit.

[0008]As for the image sensor according to claim 4, said insulating layer consists of polyimide material in the image sensor according to any one of claims 1 to 3.

[0009]The image sensor according to claim 5 is provided with a euphotic zone which consists of material in which said photodetection part has sensitivity on wavelength of not less than 1000 nm in the image sensor according to any one of claims 1 to 4.

[0010]The image sensor according to claim 6 has a euphotic zone which said photodetection part becomes from semiconductor materials other than Si in the image sensor according to any one of claims 1 to 5.

[0011]The image sensor according to claim 7 is [this invention] characterized by that the image sensor according to claim 6 comprises the following.

A euphotic zone which said photodetection part becomes from InGaAs.

n-InP layer.

p-InP layer.

[0012]

[Embodiment of the Invention]As for this invention, although the example of this invention is hereafter described with reference to drawings, it is needless to say that it is not limited to these examples.

[0013](Example 1) The 1st example of this invention is shown in drawing 1. It is the wiring whose 105 the electronic circuit where, as for 101, a Si substrate and 102 possess CCD, and 103 connect a polyimide insulating layer here, 104 connects a photodetector, and connects an electronic circuit and a photodetector. The sectional view of one pixel of this example is shown in drawing 2. As for p-InP layer and 111, the Al wiring for which the contact hole for which 106

connects a CCD circuit, 107 connects the interlayer insulation film of LSI, and 108 connects between layers was passed here, and 109 are [n-InP layer and 113] SiN insulator layers i-InGaAs layer and 112 Al wiring and 110. In order to reduce contact resistance, high dope p-InGaAsP layers may be provided between high dope n-InGaAsP layers, and the wiring 105 and p-InP layer 110 between the wiring 10 and n-InP layer 112. It is possible to receive light in this composition except for the leaver section between the photodetector 104 as a photodetection part and the adjoining photodetector 104 and the portion in which light is interrupted by the electrode, and it is possible to make the area share of a photodetector about 90%. Of course, if a suitable microlens array is arranged on the element upper surface, it cannot be overemphasized that about 100% of light can be received in an acceptance surface.

[0014]The block wiring diagram of this example is shown in drawing 3. Here, as for a line writing direction CCD array and 115, a column direction CCD array and 117 are amplifying circuits a photodetection part and 116 114. Electric and logical connection is the same as that of the conventional CCD series. The light detected in the photodetection part 115 is changed into an electron, and After [fixed] time accumulation was carried out, It is outputted to CCD of adjoining line writing direction CCD array 114, and between CCD is transmitted in order with a clock, the amplifying circuit 117 is reached through column direction CCD array 116, and the electric charge according to the light volume of each pixel is outputted from the amplifying circuit 117 in order. In this composition, there is sensitivity in the range of a grade with a wavelength of 900 to 1600 nm by that which uses InGaAs for a euphotic zone and uses InP for p/n layer in the photodetection part 115 (they are p-InP layer 110, i-InGaAs layer 111, and n-InP layer 112 in drawing 2). It cannot be overemphasized that other semiconductor materials can be used for this invention. For example, it is possible to use GaInAsSb system material and InAsSbP system material, and it is possible to use the material of a PbSSe system, a PbSnSe system, a PbSnSeTe system, and a PbSeTe system further in a far infrared region in a with a wavelength of not less than 1500 nm inside infrared region. However, in the case of far-infrared photodetection, it is necessary to cool an element. Naturally it is also possible to use Si for a photodetector. In this case, although light-receiving wavelength is the same as that of the conventional image sensor, it is possible to raise the area share. Since the capacity of a photodetector is reduced as compared with the photodetector by a CMOS process, it is effective to the 2nd example described below. In addition, semiconductor materials, such as a GaAs, germanium, and AlGaAs system, InGaAsP system, GaNAs system, GaSb, GaP, and GaAsP system, InSb, InAs, and InGaSb system, can be used for a photodetector.

[0015]Drawing 4 (a) A manufacturing method is explained with reference to - (g). What is shown in drawing 4 (a) is the substrate with which the electronic circuit 102 which already contains CCD as an integrated circuit was formed on Si substrate 101, and Al wiring 109 for connecting with the photodetector 104 (drawing 1) is exposed to the surface. Al wiring 109 may be exposed to the bottom of a contact hole. In this state, since unevenness is shown in a substrate face, flattening of a substrate is required. What is shown in drawing 4 (b) is in the state which applied the polyimide solution to the substrate face. If temperature is raised in this state, the

polyimide 118 will solidify. The polyimide 118 is ground until an electrode surface is exposed with a grinder after solidifying. Or it may leave the about thousands of A polyimide 118, it may etch with a dry etching system, and an electrode surface may be exposed. Thereby, the electronic circuit 102 containing CCD is formed on a Si substrate. The state where flattening was ground and carried out is shown in drawing 4 (c). Another polyimide insulating layer 103 is formed again, and via this, InP substrate 120 the layer system 119 of the photodetector grew up to be is stuck so that the layer system 119 of a photodetector may touch the polyimide insulating layer 103. Here, the polyimide insulating layer 103 is slightly solidified at low temperature for temporary fastening (drawing 4 (d)). Excessive InP substrate 120 is exfoliated using high-speed etching of bromine/methanol system, and chloride system selective etching in this state. In this case, selective etching is performed after using a little less than 100 microns by high-speed etching. For this reason, the selective etching layer (not shown) of InGaAs or InGaAsP is provided between the layer system 119 of a photodetector, and InP substrate 120. This selective etching layer is etched using sulfuric acid / hydrogen peroxide system etchant. This state is shown in drawing 4 (e). Next, it divides into each pixel. This is possible at the usual photolithography technique, if a mask (not shown) and alignment are carried out using the lighting of a near infrared using the marker (not shown) on Si substrate 101 from a rear face. Or the layer system 119 and the polyimide insulating layer 103 of a photodetector may be etched selectively, the electronic circuit 102 containing CCD may be exposed, and alignment may be performed using the marker established on the electronic circuit 102 containing this CCD. It is good for division into a pixel to use the reactive ion-beam-etching (RIE) device of chlorine / argon system thru/or bromine/argon system. The layer system 119 of a photodetector is separated into each photodetector 104 (drawing 1) by this division. This state is shown in drawing 4 (f). The portion of the polyimide insulating layer 103 is also divided if needed. A part of polyimide insulating layer 103 is etched with an oxygen system reactive ion-beam-etching (RIE) device etc. for wiring with Al wiring 109. Next, processing which raises temperature to the temperature which polyimide solidifies thoroughly is performed. Then, inter-electrode wiring is performed by the wiring 105. After wiring, in order to reduce resistance, about 400 ** sintering is performed. Metal barrier multilayer films, such as Ti/Pt/Au and Ti/nickel/Au, are provided between the wiring 109 and the wiring 105 if needed. This state is shown in (g).

[0016](Example 2) Drawing 5 is a block wiring diagram in which an integrated circuit shows the image sensor by the 2nd example of this invention constituted by the CMOS circuit. Here, as for a row decoder circuit and 122, a column-decoders circuit and 124 are the amplifying circuits in a pixel an amplifying circuit and 123 121. The example of a circuit of a pixel is shown in drawing 6. Operation of the image sensor by this example will be read, if it is the same as that of the usual CCD series, the electric charge which received and carried out photoelectric conversion within the cycle of a reset clock is accumulated and line specification is enabled, it is amplified in the amplifying circuit 122, and is memorized by the register in the column-decoders circuit 123. By performing this one by one, parallel serial conversion of the image information is carried out, and it is outputted. The image sensor by this example can be manufactured in accordance with

the same manufacturing method as the image sensor by the 1st example.

[0017]Although the image sensor by the 1st and 2nd examples was explained as a two-dimensional image sensor, it cannot be overemphasized that this invention is applicable to a one-dimensional linear image sensor.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a lineblock diagram of the image sensor by the 1st example of this invention.

[Drawing 2]It is a sectional view of the image sensor by the 1st example of this invention.

[Drawing 3]It is a block wiring diagram of the image sensor by the 1st example of this invention.

[Drawing 4]It is a sectional view explaining the manufacturing method of the image sensor by the 1st example of this invention, The substrate with which the electronic circuit where (a) contains CCD was formed, the substrate with which (b) applied polyimide, The substrate which (c) ground and carried out flattening, the substrate in the state where (d) was able to stick the p-Inp board with which the layer system of the photodetector grew up to be polyimide, the substrate, with which (e) performed selective etching, the substrate which divided (f) into each pixel, and (g) show the substrate which performed inter-electrode wiring, respectively.

[Drawing 5]It is a block wiring diagram of the image sensor by the 2nd example of this invention.

[Drawing 6]It is a circuit diagram of the pixel of the image sensor by the 2nd example of this invention.

[Description of Notations]

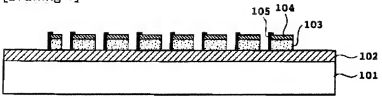
101 Si substrate
102 The electronic circuit containing CCD
103 Polyimide insulating layer
104 Photodetector
105 Wiring
106 CCD circuit
107 The interlayer insulation film of LSI
108 Al wiring
109 Al wiring
110 p-InP layer
111 i-InGaAs layer
112 n-InP layer
113 SiN insulator layer
114 Line writing direction CCD array
115 Photodetection part
116 Column direction CCD array
117 Amplifying circuit
118 Polyimide
119 The layer system of a photodetector
120 InP substrate
121 Row decoder circuit
122 Amplifying circuit
123 Column-decoders circuit

* NOTICES *

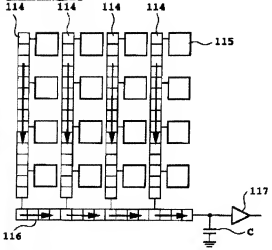
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

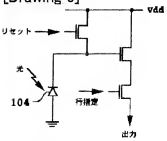
[Drawing 1]



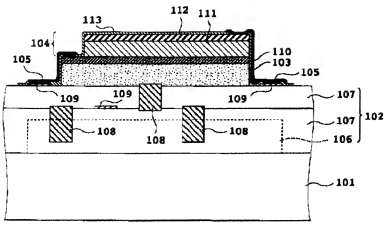
[Drawing 3]



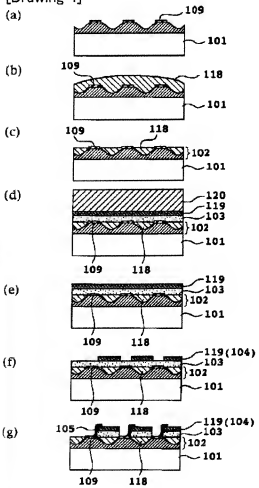
[Drawing 6]



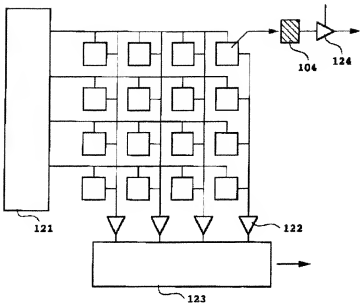
[Drawing 2]



[Drawing 4]



[Drawing 5]



[Translation done.]